ANALYSIS

by Dr Carlo Kopp

WEDGETAIL – HOW MANY IS ENOUGH?

In a recent editorial in Fairfax newspapers, Australian Strategic Policy Institute Director Hugh White pointed out the unfortunate reality that Defence remains on track to purchase only four Wedgetail AEW&C aircraft and two additional mission packages for $3.6bn, not taking up the option to add two airframes at an additional seven percent increase to get six complete systems. As he observed, a 50 percent increase in capability for a seven percent increase in price is hard to argue with.

Aside from issues of sloppy resource management in the Defence bureaucracy, an argument in its own right, this does raise the important question of what number of Wedgetails would be appropriate for the RAAF force structure.

The current number of four aircraft and two mission systems was a compromise, agreed to after a much publicised National Security Committee (NSC) meeting in which the then Department of Defence leadership was unable to successfully articulate the strategic case for the originally planned six aircraft and one option.

But there is a compelling case for the ADF operating more than four Wedgetails, and with the options on two new airframes (allowing six complete Wedgetail aircraft) about to expire, it is worth exploring the capabilities of the Wedgetail and regional trends in air and missile power.

AEW&C in the Region

The massive growth observed across the wider region in modern airpower is not limited to the acquisition of hundreds of advanced Sukhoi fighters, now in service with or ordered by India, China, Indonesia, Malaysia and Vietnam.

China is now well on the way to full production of its IAI Lavi-like J-10 fighter, and is evidently investing heavily in developing a significant indigenous cruise missile capability. Across the region we have seen buys of Russian subsonic and supersonic cruise missiles, including the Sunburn/Moskit, Yakhont/Brahmos, Uran/Kharpunski, Alfa/Club/Kalibr, Ovod and others. India has taken delivery of Il-78MKI tankers, while China continues its program of converting H-6 Badger bombers into tankers.

The drive to equip Asian force structures with modern fighter, tanker and precision weapons capabilities is paralleled by an ongoing focus on fielding AEW&C capabilities within the region. The pivotal role of AEW&C aircraft in the Desert Storm, Desert Fox, Allied Force, Enduring Freedom and Iraqi Freedom campaigns has been well understood across Asia and the shopping spree reflects this.

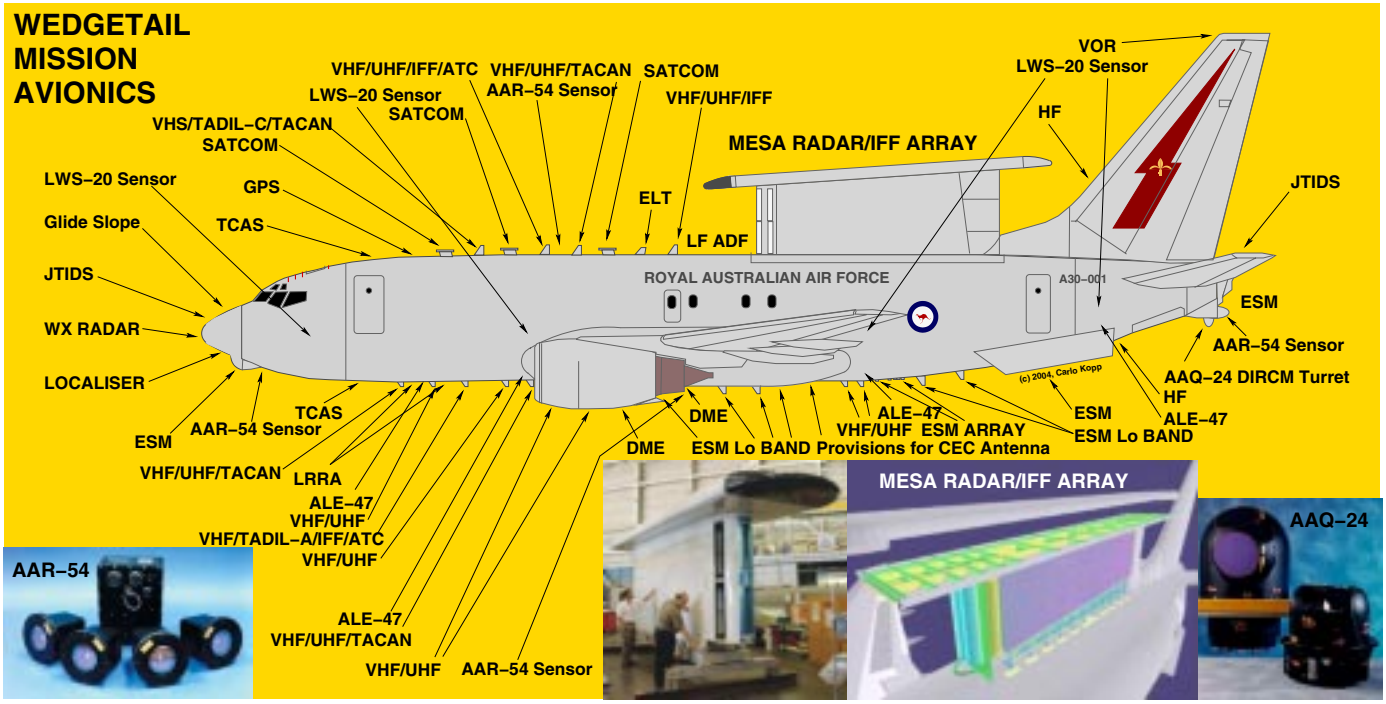
The earliest regional adopters were Japan with no less than 13 E-2C Hawkeyes and four E-767 AWACS, Singapore with four E-2C Hawkeyes, and Taiwan with six E-2T/2000 Hawkeyes between 1994 and 2000. All island nations with larger and not always cordial neighbours, they invested to provide critical air defence coverage.

Of more interest is the second wave of buys, which materialised in the late 1990s, when Australia decided on the Wedgetail solution.

China's PLA-AF entered a multi-billion dollar deal with Israel to integrate a variant of the Elta Phalcon phased array radar on the Russian Beriev A-50/Ilyushin Il-78M airframe (at the same time Raytheon was offering Australia a Wedgetail solution of an Elta Phalcon equipped Airbus A310). The Russian A-50 AWACS system was to be gutted and replaced with the three sided L-band AESA (active phased array) radar and supporting systems, providing the PLA-AF with one of the most advanced systems worldwide.

This ambitious plan collapsed in July 2000, when the US objected to the export of such a capable package to China. This effectively killed the deal at Cabinet level. Amid much face saving rhetoric about 'humiliation', the Chinese declared that the Russian A-50U/E would be acquired instead. More recently, the radome equipped A-50I prototype has been observed flying over Nanjing, presumably without the Phalcon installation. While the issue has been quiet in the press, there is no doubt that China will field an AWACS over the coming decade – the only uncertainties being in timing, numbers and type.

China's misfortune was India's fortune. With quiet US approval India earlier this year signed with Israel for several Phalcon equipped A-50I AWACS to be delivered later in the



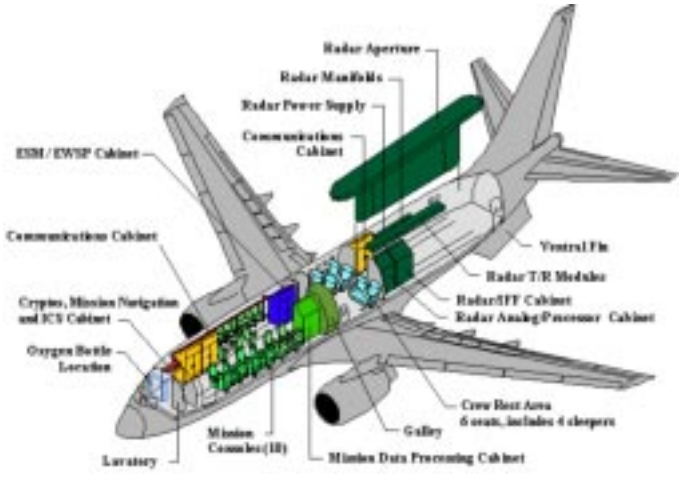
The Wedgetail will be equipped with a comprehensive mission avionics suite, rivalling that of the late model E-3 AWACS, but more compact and cheaper. The L-band MESA radar/IFF array is likely to be the basis of the US Air Force's AWACS replacement early in the next decade. The extensive defensive suite is the first on an AEW&C/AWACS platform. (Author, Northrop Grumman)

decade. The exact configuration has not been disclosed, but given India's increasing propensity to import Israeli hardware, odds are the aircraft will carry a comprehensive package of Israeli ESM and communications hardware.

In the nearer region, Malaysia declared its interest in June last year to acquire four AEW&C aircraft, with reports indicating that the Embraer EMB-145/Erieye, Northrop Grumman E-2C Hawkeye 2000 and the Boeing 737 Wedgetail were under consideration. Malaysian press reports put the requirement to be urgent enough to delay the buy of additional Sukhois to cover this need.

The pattern of Asia's Sukhoi buys was that small initial batches were ordered, followed by much larger follow-on buys. This can also be expected for both China's and India's AEW&C fleets, as both try to match or exceed each others' capabilities. There can be little doubt that by 2020 almost every regional nation of strategic interest to Australia will have AEW&C fleets, some of which might be numerically quite significant.

The Wedgetail system has grown since 1999 proposals were published, with ten multi-function consoles for operators, a similar number to the E-3 AWACS. This provides significant growth potential for the system's roles and missions. A rest area is included to permit operator rotations on extended duration sorties (Boeing).



Australia's 'Pocket AWACS'

The Wedgetail AEW&C aircraft configuration ordered for the RAAF is the technologically most advanced design worldwide, and in terms of radar performance more than a match for its regional competitors.

The airframe used is the Boeing 737-700IGW, essentially a -700 fuselage mated with stronger -800 wings and undercarriage (the same airframe used by the Boeing Business Jet or BBJ now in RAAF VIP service). This airframe is also the basis of Boeing's MMA proposal for a P-3C Orion replacement. Advertised performance includes a dash speed of 460 knots, range of 3000nm (5560km), and time on station without refuelling in excess of eight hours (with an aerial refuelling receptacle to extend time on station).

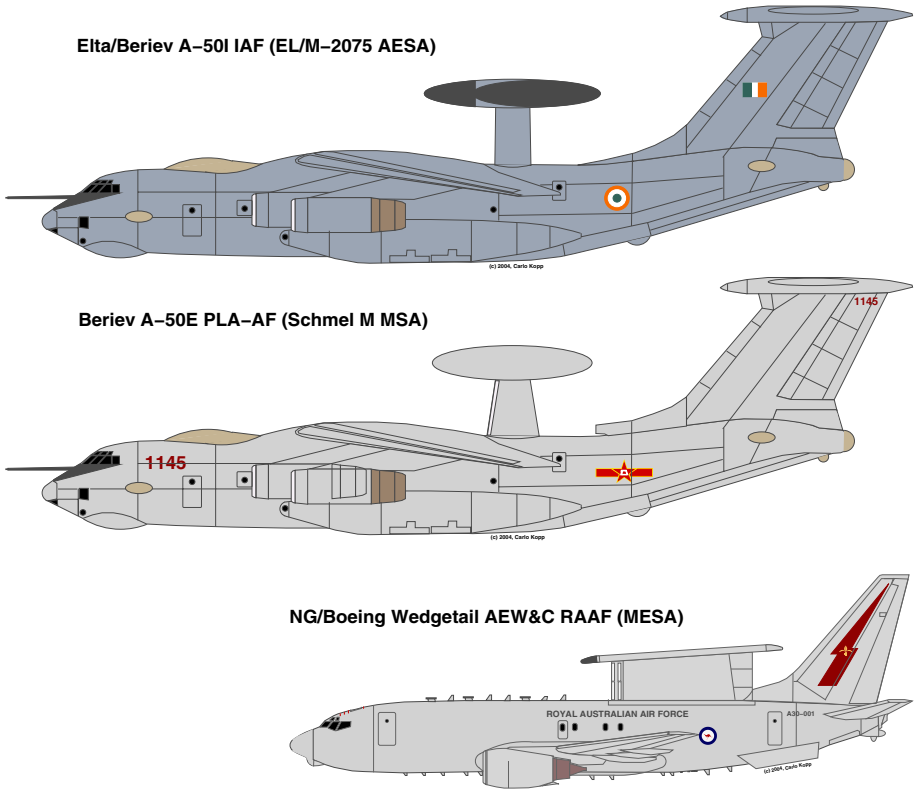
The CFM56 turbofan powered Wedgetail has a station altitude between 30,000 and 40,000ft, providing an important advantage in low level radar horizon distance against turboprop competitors. Low level footprint is a critical parameter in both maritime air defence and cruise missile defence roles.

The configuration of the system has evolved since the initial public disclosures at the time of the tender. While the basic layout of a forward fuselage mission deck with six operator consoles and cabinets with racked crypto, communications, ESM and data processing equipment, a centre fuselage crew rest area, and an aft fuselage radar/IFF equipment area is retained, current diagrams indicate that 10 operator consoles will be used. To place this in context, the original E-3A AWACS configuration had nine to 11 consoles, while smaller AEW&C platforms like the E-2C have three to four consoles. Additional consoles provide for additional growth in roles – the console design is a new commercial technology based 'soft' design where all display formats are produced in software, permitting instant reconfiguration to whatever mode is desired. In the future a Wedgetail could absorb the battle management roles now planned in the US for the MC2A series of AWACS/JSTARS/Rivet Joint replace-

ments. The networked and racked open systems based commercial off-the-shelf computing package will permit much evolution over the service life of the system.

The core of the mission avionics suite is the Northrop Grumman MESA L-band (1.215-1.4 GHz) surveillance radar with an integrated IFF capability, feasible due to the overlapping radio frequency band coverage of the radar function. The MESA is an active array (or AESA) – each antenna element is driven by an integrated Transmit-Receive (TR) module with internal phase shift and radio frequency gain controls. This provides the type of time-sharing and sector scan capabilities most widely seen today in the Aegis destroyers' SPY-1 series phased array, but the MESA does so with significantly lower sidelobe performance of an active array and the inherent reliability which comes with over a thousand independent solid state TR modules.

The MESA is an important innovation in the airborne AESA game as it provides 360 degree coverage in a compact and low drag lightweight package. Beam aspect coverage is provided by left and right looking 'slab' array apertures, while fore and aft aspect coverage is provided by endfire mode 'top hat' aperture, in the surfboard shaped upper structure. Best radar performance is in the beam sectors, used most frequently in AWACS style orbit orientation. The TR modules are racked in the upper fuselage for ease of maintenance, with feeds running into the external antenna structure. With no moving parts the MESA will be exceptionally reliable in service – unlike troublesome mechanically steered AEW&C radar antennas with rotational couplers.



The region is seeing ongoing orders for AEW&C capabilities. Japan, Singapore and Taiwan operate E-2C Hawkeye variants, Japan the E-767 with an E-3 AWACS mission package, and India this year ordered the A-50I with a variant of the Phalcon phased array radar originally bid for the Wedgetail program. The PRC is expected to buy the Russian A-50U/E, and are now flying the recovered A-50I prototype (Author).

The MESA is well suited to the developing regional environment. The use of the L-band wavelength provides excellent penetration of heavy (cyclonic) weather, an issue for shorter wavelength radars. This radar band also defeats many 'add-on' stealth coatings and shaping measures which are optimised for the centimetric bands. L-band wavelengths resonate nicely with many feature sizes on combat aircraft, as distinct from centimetric band JSTARS like radars optimised for ground vehicles. In cruise missile defence, L-band is not always considered optimal, but the phased array and good station altitude can offset to some extent radar physics – a much increased number of radar pulses over time can still effect good detection performance against such small targets.

The phased array configuration permits highly flexible allocation of radar dwell time in space – basically permitting more energy to be put into specific areas of interest. While the radar can be used to sweep 360 degrees like a mechanically steered design, it can also focus all of its energy into a narrow threat sector to increase effective range performance, or it can timeshare between these two regimes to maintain 360 degree background coverage while increasing detection and tracking performance in a narrow sector of interest. The latter regime has proven very useful in naval Aegis radar operations in complex littoral environments.

The ability to focus energy into sectors permits higher update rates on target tracks, and higher track confidence levels against distant or faint targets. In an environment where larger supersonic combat aircraft and supersonic cruise missiles are common, this is a valuable capability.

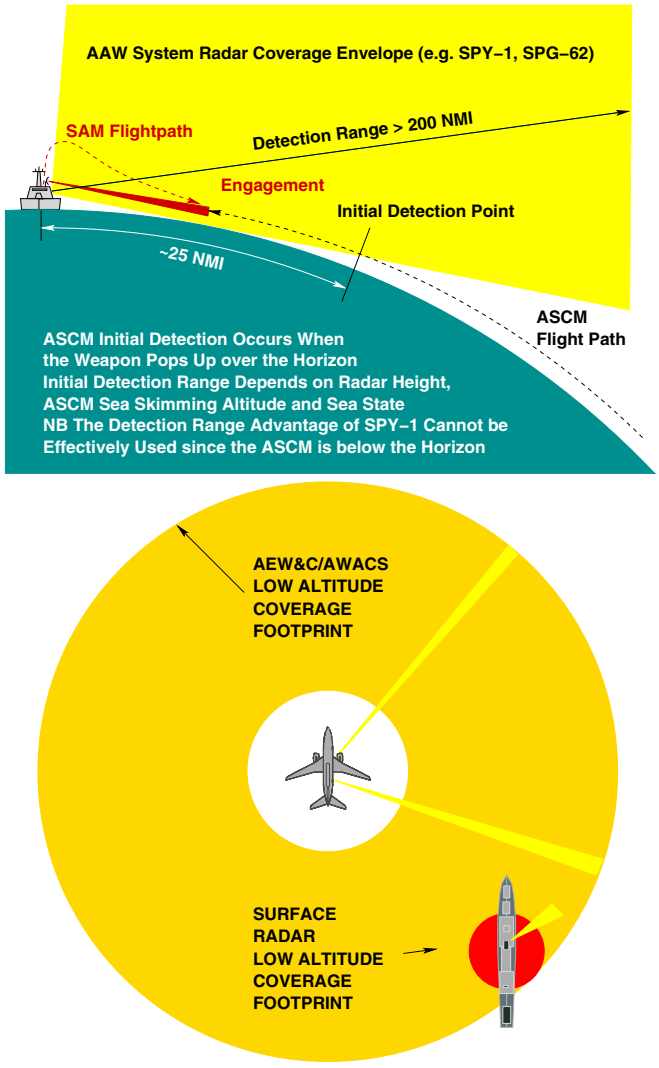
The MESA is supported by a communications/datalink suite and the ALR-2001 Electronic Support Measures (ESM) used to passively detect hostile emitters. Three HF voice/data channels, ten VHF/UHF (Have Quick II) frequency hopping radio channels, four UHF voice/data channels, UHF MILSATCOM voice/data, Link-11, OTCIXS and JTIDS/Link-16 provide a comprehensive package permitting connectivity with air, land and maritime surface assets (refer figure 1). Space is provided for a US Navy style CEC antenna for maritime operations. The system best compares to the late model E-3 AWACS suite.

The defensive package is also comprehensive by established standards, including an ultraviolet band Northrop Grumman AAR-54 Missile Warning Receiver coupled to an AAQ-24 Directed IR Counter Measures turret in the tail, an Elisra LWS-20 Laser Warning Receiver, and multiple ALE-47 countermeasures dispensers, capable of carrying flares, chaff or expendable radar seduction jammers such as the AM 6988 POET or RT-1489/ALE Gen-X. It has not been disclosed whether the AAR-24 is a lamp or laser equipped variant. Absent in the defensive suite is an internal microwave band trackbreaking jammer which might become a necessity in the future, as long range counter-ISR missiles like the Kh-31 and KS-172 series proliferate further.

There is little doubt that the Wedgetail sits at the pinnacle of current AEW&C/AWACS technology and performance, yet is an affordable, relatively lightweight package. It is likely to become the basis of the US Air Force MC2A AWACS replacement, currently in definition.

How Many Wedgetails is Enough?

What the Wedgetail provides is a system which combines 250nm (465km) class 360 degree all altitude radar and ESM



COMPARATIVE FOOTPRINT OF AIRBORNE VS SURFACE RADAR
Assumed Target Altitude ~30–50 ft AMSL

There is no contest between the low altitude radar coverage achievable by a Wedgetail, compared to a surface warship. As the laws of physics do not permit warships to see around corners, it takes dozens of Air Warfare Destroyers to match the low level coverage of a single Wedgetail system. In a region dominated by growing anti-ship and land attack cruise missile inventories, the rationale for long range shipboard radars is difficult to support, unlike the rationale for more Wedgetails. (Author)

surveillance coverage, comprehensive digital and voice connectivity, and battle or mission management functions, all in a single rapidly deployable and persistent package. Within the footprint of the Wedgetail all airborne traffic, maritime surface traffic and most emitters and cruise missiles can be detected and tracked. While JORN provides long range wide area coverage, it cannot provide the accurate height finding and position tracking, passive detection, communications and rapidly updated tracking functions of the Wedgetail – the two systems are complementary, not mutually exclusive.

In modern military terms the Wedgetail provides a comprehensive situational picture within its footprint, and the voice/data communications required to manage any ADF assets within reach.

In 'classical' land and maritime air defence operations the Wedgetail, in concert with fighters and tankers, would be used to support intercepts against hostile aircraft and where applicable, cruise missiles, by RAAF fighters. Moreover, its situational picture can be relayed to RAN surface assets, Army missile batteries, and distant ADF headquarters. In the air defence game, early warning is one of the most precious commodities, as it permits assets to be marshalled and readied for engagements. Every conflict since the Battle of Britain proves this beyond a shadow of a doubt.

In strike warfare the Wedgetail is no less valuable. Other than fulfilling the air control functions seen in air defence, it can be used for 'air traffic control' management of strike aircraft, but also to relay a situational picture of hostile surface air defence (via ESM) and fighter (via radar and ESM) dispositions to penetrating strike aircraft. Bypassing defences always beats shooting your way through them.

In purely surface bound maritime warfare, the Wedgetail provides the RAN with a complete picture of opposing assets, vital in littoral combat, blue water surface operations and convoy escort – consider a Timor-like or Falklands-like contingency with anti-ship cruise missile firing warships, patrol boats and helicopters targeting troop transports. Comparable gains arise in land warfare, as enemy heliborne and seaborne forces can be tracked in real time.

To these wartime uses we can add a range of peacetime roles. Wide area surveillance of air and sea traffic permits interdiction of people/contraband smugglers, movements of insurgents and terrorists, 'factory ship' poaching of fisheries and search and rescue operations. The large footprint of a Wedgetail compared to the lower power radar on a UAV or maritime patrol/Coastwatch platform permits a single Wedgetail to surveil several times the area in much more detail, much faster.

The Noble Eagle operation post 9/11, when the USAF bolstered its E-3 AWACS fleet with NATO E-3s to ensure interception of hijacked airliners, is another contingency where Wedgetails would prove invaluable – be it for surveilling Australian airspace or on loan to allies like the US.

In coalition warfare campaigns the US Air Force has repeatedly run short of E-3 AWACS and trained crews, frequently borrowing from the UK E-3D fleet to augment its own. With the US facing 'global overstretch' over coming decades, every Wedgetail we have is a politically and strategically valuable ADF campaign contribution without the political encumbrances which come with dropping live munitions. It takes no genius to observe that prime ministers of either political persuasion will be attracted to the high payoff, high visibility, low risk Wedgetail as a coalition campaign contribution.

The reality is that once the ADF has operational Wedgetails, the aircraft will be in high demand for peacetime surveillance and coalition warfare operations, aside from their important deterrent effect across the wider region. Were they operational in 2001, odds are much of the fleet would have been deployed to the US or Afghanistan.

This brings us to the central question of how many Wedgetails should the ADF be operating. Four aircraft is patently inadequate given the expected long term demand, for defence of the continent and sea air gap, aside from coalition warfare demands.

Key observations are that:

• A single Wedgetail aircraft can continuously surveil a circle of about 450nm (835km) diameter for low altitude airborne and maritime surface targets.

• To provide continuous coverage of a single immediate area of operations requires a pair of AEW&C aircraft, plus an additional spare should one of these aircraft experience technical difficulties. Full 24/7 coverage would be essential if an opponent used submarine launched cruise missiles, as these may be launched with no warning, or longer ranging air launched cruise missiles. Both categories are proliferating across the region at this time.

• To provide on-demand coverage of a single immediate area of operations, launching on a JORN track, requires one AEW&C aircraft, plus an additional spare should this aircraft experience technical difficulties. This is required for a fighter

or bomber threat, without longer ranging cruise missiles.

• The air defence of the North West Shelf area, the Darwin area and the Timor Sea would each require a pair of aircraft for 24/7 coverage, with one spare aircraft shared between the three areas. This requires a total of seven aircraft.

• The air defence of the North West Shelf area, the Darwin area and the Timor Sea would each require one aircraft for on-demand coverage, with one spare aircraft shared between the three areas. This requires a total of four aircraft.

• Any major strike operation performed in the region would require at least one aircraft, plus an available spare. Conditions may require that the spare is airborne for the mission. It is unlikely that such a contingency would arise without the risk of opposing air strikes against the continent.

• In practice one aircraft might be in the depot for airframe maintenance, hardware and software upgrades and testing. Therefore full fleet availability could not be guaranteed at very short notice, but is feasible with several months of warning time.

Conclusions: with four aircraft the RAAF could not provide continuous air defence coverage between the North West Shelf and Darwin areas. At least seven aircraft would be required to be effective against an air or sub launched cruise missile armed opponent.

With four aircraft the RAAF could not provide AEW&C support for strike operations if on demand air defence coverage is required between the North West Shelf and Darwin areas. At least six aircraft would be required, assuming threat strike aircraft with shorter ranging weapons. Should Australia need to provide short notice on-demand air defence cover to protect all capitals against the threat of hijacked airliners, as has occurred in the US, then four aircraft would permit coverage for only three capitals.

It is clear that if the Defence of Australia is the priority, then a fleet of seven or more Wedgetails is the appropriate number. If coalition warfare is the priority, while retaining contingency coverage for the eastern seaboard capitals, or on demand coverage for the north, then more than four aircraft are required – assuming a coalition deployment of three to four Wedgetails, the total comes in at seven to eight.

The critical mass number for a properly sized Wedgetail fleet is above six aircraft, with seven being better, and eight better still. Four aircraft would be insufficient to support either a doctrine of continental defence or prioritised coalition warfare.

In this context it is worth observing that the intended multi-billion dollar investment in SPY-1 Aegis equipped Air Warfare Destroyers provides neither a substitute nor a complement for additional Wedgetails. While the SPY-1 system provides excellent long range high altitude coverage, the reality is that regional players are equipping with a plethora of sea skimming or low altitude anti-ship and land attack cruise and standoff missiles.

A surface warship defending a convoy, surface action group or amphibious landing will be confronted with launch platforms and cruise missiles attacking from standoff ranges and low altitudes. Acquisition of such threats is not an issue for the Wedgetail, but is geometrically impossible for any warship – it will be blind until the last one to three minutes of the weapons' flight to impact. A single Wedgetail provides such low altitude coverage equivalent to about 60 surface warships.

Taxpayers and legislators might want to ask the question of why the investment is being put into such large warships, rather than additional Wedgetails. Smaller warships with X-band radars like the SPY-3 optimised to stop saturation cruise missile strikes would be a much better fit to the developing regional capability mix, used in concert with Wedgetails to provide over the horizon missile targeting.

This also begs the question of how seriously the 'joint' paradigm is being taken inside the Defence Department, when investment is being focused to favour a single service preference regardless of its lesser practical utility to that service and the ADF as a whole.

The new design consoles in the Wedgetail build on three decades of experience with the E-3 AWACS, but use COTS hardware and software to provide best possible capability at affordable costs. Demonstrators used Unix hosting hardware and X11/Motif windowing software (Boeing).

In summary, there is an overwhelming case to get six or more Wedgetails, rather than four, regardless of the ideological and military/strategic doctrines used to define the ADF's long term force structure. It is disappointing that the Defence leadership has not managed as yet to publicly articulate an intellectually rigorous strategic case for a larger Wedgetail fleet, since such a case clearly exists.

If the current Defence Capability Plan is pursued the ADF will end up prematurely burning the airframe life out of an undersized Wedgetail fleet, spread too thinly to yield viable strategic or political effect.

Future articles will address regional force structure and cruise missile capabilities in much more detail.

The Wedgetail's software intensive system will permit the use of a wide range of flexible, graphics intensive synthetic display formats, which can fuse radar, ESM, datalink and digital mapping outputs. These demonstrator displays illustrate the style of presentation to be used. This technology permits rapid growth to incorporate offboard data sources such as UAVs, satellites and ground based databases (Boeing).